



# **An Unnecessary Burden: Indoor Chemical Exposure and Asthma**

**Maryland PIRG Foundation**

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Indoor Chemical Exposure and Asthma



Jenny Levin, Maryland PIRG Foundation

Emily Scarr, Maryland PIRG Foundation

Travis Madsen, Frontier Group

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# Table of Contents

EXECUTIVE SUMMARY .....	1
INTRODUCTION .....	3
ASTHMA IS A MAJOR PUBLIC HEALTH PROBLEM IN MARYLAND .....	4
<i>CHILDHOOD ASTHMA PREVALENCE IN MARYLAND IS RISING FASTER THAN IN THE U.S. AS WHOLE</i> .....	4
<i>ASTHMA COSTS MARYLAND MILLIONS FOR HEALTH CARE AND LOST PRODUCTIVITY</i> .....	5
<i>WHY IS ASTHMA PREVALENCE RISING?</i> .....	6
<i>CHILDREN ARE PARTICULARLY VULNERABLE TO HARM</i> .....	6
<i>DISPARITIES IN ASTHMA INCIDENCE</i> .....	7
EXPOSURE TO TOXIC CHEMICALS CAN CAUSE OR AGGRAVATE ASTHMA .....	8
<i>COMMON CONSUMER PRODUCTS CONTAIN TOXIC CHEMICALS LINKED WITH ASTHMA</i> .....	8
PHTHALATE EXPOSURE MAY INCREASE ASTHMA RISK .....	9
BISPHENOL-A ALTERS IMMUNE SYSTEM DEVELOPMENT IN WAYS THAT COULD INCREASE ASTHMA RISK .....	10
<i>SOME VOLATILE ORGANIC POLLUTANTS CAUSE OR AGGRAVATE ASTHMA</i> .....	11
DIISOCYANATES CONTINUE TO BE WIDELY USED, DESPITE HAZARD .....	12
GLYCOL ETHER EXPOSURE IS COMMON .....	13
FORMALDEHYDE EXPOSURE DAMAGES THE LUNGS .....	13
<i>CLEANING PRODUCTS HAVE LINKS WITH ASTHMA</i> .....	14
MARYLAND SCHOOLCHILDREN AND TEACHERS AT RISK .....	15
CLEANING PRODUCTS USED IN SCHOOLS CONTAIN CHEMICALS TIED TO ASTHMA .....	16
SUCCESSFUL STATE PROCUREMENT OF SAFE CLEANING SUPPLIES .....	16
PROTECTIONS NEEDED DURING CONSTRUCTION AND RENOVATIONS .....	17
STATE AND FEDERAL CHEMICAL REGULATIONS FAIL TO PROTECT OUR HEALTH .....	18
POLICY RECOMMENDATIONS .....	19
<i>RIGHT TO KNOW</i> .....	19
EDUCATE MARYLANDERS ABOUT CHEMICALS OF CONCERN .....	19
STATES REQUIRE DATA REPORTING .....	19
<i>STREAMLINE ACTION ON THE WORST CHEMICALS</i> .....	20
<i>PREVENTION EFFORTS SHOULD TARGET VULNERABLE POPULATIONS, SCHOOLS, HEALTHCARE PROVIDERS</i> .....	20
<i>USE THE BEST SCIENCE AND METHODS</i> .....	21
<i>PROMOTE SAFER ALTERNATIVES AND MARYLAND-BASED INNOVATION</i> .....	21
ENDNOTES .....	22

# Executive Summary

The chronic lung disease asthma is the most common disease affecting children in Maryland, and rates of asthma continue to rise. As of 2010, 16.4% of children in Maryland were reported to have suffered from asthma, compared to a national rate of 12.6%. In the United States as a whole, the prevalence of children with asthma has more than doubled since 1980. Asthma is a major health and financial hardship on families, schools, and the healthcare system.

Exposure to asthma-inducing outdoor air pollution, allergens like dust mites, and genetics, cannot fully explain the rising rates of asthma incidence. Exposure to toxic chemicals indoors may also play a role.

This report focuses on the impacts of toxic chemicals in consumer products on asthma and asthma symptoms. A large and growing body of scientific research shows that many chemicals in consumer products and building materials are linked to asthma and asthma symptoms. Babies and young children are particularly vulnerable to harm, as is the developing fetus.

Exposure to toxic chemicals can cause and aggravate asthma. Some toxic chemicals – such as phthalates, bisphenol-A or PCBs– have been linked to asthma risk and may be contributing to the rising incidence of asthma. In addition, certain chemical exposures can also trigger asthma attacks or cause asthma symptoms like wheezing or coughing.

Maryland needs to take greater action to make the products in our lives safer to use, inform the public of the risks associated with chemicals in consumer products, and reduce our exposure to substances that can cause or worsen asthma and other serious diseases.

**Common consumer products can pollute the air inside our homes with toxic chemicals that have been linked to asthma development and/or aggravation. For example:**

Flooring made from polyvinyl chloride (PVC plastic) emits phthalates. Children and adults in homes and workplaces containing high levels of phthalates are more likely to have been recently diagnosed with asthma or have asthma symptoms.

Many common items, such as canned food containers and store receipts, contain bisphenol-A, a chemical that mimics a hormone crucial for regulating proper growth and development. Infants exposed to bisphenol A in the womb or early in life are more likely to develop increased sensitivity to allergens or symptoms of asthma later in childhood.

Solvent-based paints, spray insulation, flooring adhesives and similar products can pollute indoor air with VOCs such as toluene, diisocyanates and benzene compounds. These chemicals can induce inflammatory reactions in lung cells and have been associated with increased risk of developing asthma.

Many food, pharmaceutical, cosmetic, cleaning and paint products contain glycol ethers. Children exposed to higher levels of these chemicals in indoor air are more likely to suffer from asthma and related allergic diseases.

A single piece of furniture containing high levels of formaldehyde-containing glue – often used in composite wood materials -- can contaminate the indoor air within a home at levels linked with respiratory symptoms and asthma diagnosis.

**Marylanders need better protection from exposure to toxic chemicals in consumer products. Options for policy-makers and health advocates:**

- Require that chemical manufacturers publicly disclose information on the uses of and health hazards associated with their chemicals and the ways that people could be exposed in their homes, schools, or places of work.
- Publish and maintain a list of chemicals of concern that includes the health hazards associated with chemicals of concern and the ways that people could be exposed in their homes, schools, or places of work.
- Restrict harmful chemicals from consumer products and the built

environment where appropriate, beginning with the worst chemicals and applications to which vulnerable population are exposed;

- Increase and sustain targeted prevention programs that help Marylanders eliminate chemical asthma triggers.
- Implement existing laws that support green cleaning in schools and Integrated Pest Management in schools.
- Adopt protections for children and school personnel during construction and renovation, as New York and Connecticut have done.
- Utilize state Medicaid program powers under the Affordable Care Act to cover home environmental health assessments for children with severe and persistent asthma.
- Utilize existing Maryland oversight structures such as the Maryland Children's Environmental Health and Protection Advisory Council and the Maryland Asthma Control Plan to assess additional policies to protect people with asthma from chemical exposures.

## Introduction

Consumer products and materials used in the built environment can release toxic chemicals that then circulate through indoor air or accumulate in household dust, becoming a part of our very bodies.<sup>1</sup> Levels of chemical contamination in household dust are mirrored in residents' blood and in mothers' breast milk.<sup>2</sup> Some chemicals are so resistant to breakdown that they still show up in household air and dust decades after they are banned.<sup>3</sup> These chemicals have become such a close part of our lives that scientists can find more than 100 industrial chemicals and pollutants in the bodies of every mother and child.<sup>4</sup>

As this report explores, chemical exposures may be part of the explanation for why childhood asthma rates in Maryland—and in the U.S. in general—are on the rise. We focus on recent peer reviewed research which presents a link between chemicals found in consumer products and asthma. This growing body of evidence demonstrates that various kinds of chemicals

commonly found in our homes, schools and workplaces continue to put the public, and especially children, at risk for asthma development and aggravation.

Local, state, and federal government should focus on reducing our exposure to toxic chemicals. We need to ensure that information is available to make responsible choices as a society about what chemicals we choose to include in our lives – and our bodies. We need rules to require manufacturers to use safer alternatives to the most dangerous chemicals. And we need to be able to remove the toxic threats to Marylanders when necessary. These changes are not only required of us to protect the health and wellbeing of Marylanders, but essential to keep the cost of asthma care under control. As the research in this report suggests, removing indoor chemical asthma triggers may be a critical tool for managing asthma in children and adults.

# Asthma Is a Major Public Health Problem in Maryland

Asthma is a chronic lung disease that inflames and narrows the airways, causing recurring periods of wheezing, chest tightness, shortness of breath, and coughing. It is the most common disease afflicting children in Maryland, imposing serious costs in our health care system and our schools. And the number of children suffering from asthma is on the rise. Across the United States as a whole, the prevalence of children with asthma more than doubled from 1980 to 1995<sup>5</sup>, and over the last 10 years, the number of people with asthma in the U.S. increased by nearly 15%.<sup>6</sup> One in 11 children and 1 in 12 adults in the U.S. have asthma.<sup>7</sup>

## Childhood Asthma Prevalence in Maryland Is Rising Faster Than in the U.S. as a Whole

Between 2003 and 2010, current childhood asthma prevalence in Maryland increased more than 30 percent, and lifetime asthma prevalence in Maryland children increased more than 40 percent. In 2010—the latest data available—the number of Maryland children with a history of asthma was approximately 216,000 children, or 16.4%, while the national rate of was just 12.6% . Maryland children with current asthma in 2010 exceeded 155,000, or 11.9% of Maryland children under 18, while the national rate for children suffering from asthma was just 8.4%.

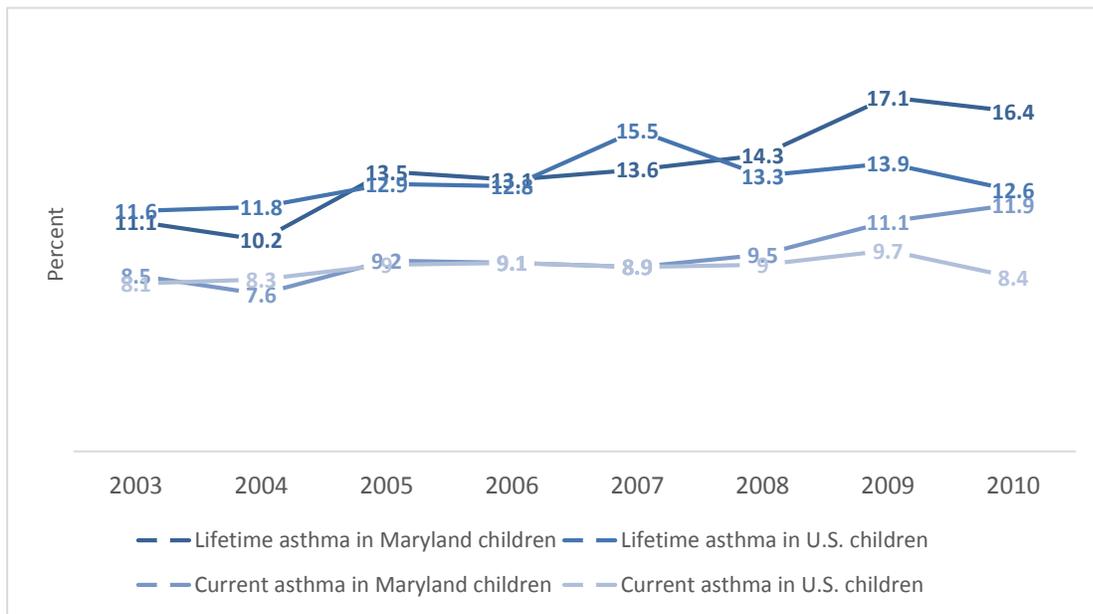


Figure 1: The Prevalence of Childhood Asthma in Maryland Is Increasing (Source: Maryland Department of Health and Mental Hygiene.)

These statistics make asthma the most common chronic disease of childhood, in Maryland and the U.S. Unfortunately, Maryland is facing a greater asthma burden than the many other states.

## **Asthma Costs Maryland Millions for Health Care and Lost Productivity**

As the U.S. Centers for Disease Control and Prevention (CDC) states, “asthma is common, deadly, disruptive, and expensive.” The CDC reports that the total cost of asthma care nationwide exceeds \$55 billion every year, and that the average yearly cost of care for a child with asthma in 2009 was \$1,039.<sup>8</sup>

Asthma burdens our health system in other ways as well. Asthma lead to almost 9 million visits to the doctor and two million trips to the emergency room each year in 2009. Asthma is the leading cause of school absenteeism due to a chronic condition, accounting for more than 14.7 million missed school days per year. Childhood asthma also accounts for many nights of interrupted sleep, limits of daytime activities, and disrupts routines. Asthma is the fourth leading cause of missing work and reduced work productivity for adults.

Asthma care imposes large costs on Maryland citizens. It is the third-leading cause of hospitalizations for children under the age of 15.<sup>9</sup> In fact, Baltimore has the highest pediatric asthma hospitalization rate in Maryland and one of the highest in the nation.<sup>10</sup> Hospital charges for inpatient asthma treatment exceeded \$28 million, plus an additional \$12 million for treatment in an emergency department.<sup>11</sup>

Asthma hospitalizations in Maryland have increased almost 13.5% from 2001 to 2010. Maryland asthma hospitalization rates were lower than the United States until 2005. Since then, Maryland’s rates have continually remained higher than the nation.<sup>12</sup>

In 2010, asthma emergency department visit rates exceeded the Healthy People 2010 goals for the age groups of 0 to 4 year olds and 5 to 64 year olds. This difference remains most dramatic for children under 5 years of age. The Healthy People 2010 goal is 80 visits per 10,000 population, yet Maryland’s youngest children (ages 0-4) had 199.7 visits per 10,000 population.

In Maryland, asthma contributes to school absenteeism. In 2007, 28 of high school students in Baltimore City reported having been diagnosed with asthma, compared to just 20 percent of students nationwide.<sup>13</sup>

19.2% of parents reported that their child missed 1-2 days of school because of asthma during the past year and 9.7% said their child missed over 7 days due to asthma.

## Why Is Asthma Prevalence Rising?

Asthma attacks occur when a trigger – which could include exercise, an infection, allergens like pollen or dust mites, or airborne irritants like smoke or ozone pollution – causes small muscles surrounding small air passages in the lungs to contract, preventing normal breathing. Asthma is closely tied to the function of the immune system. If the immune system is overly sensitized, it can react more severely to potential threats, causing asthma attacks.

Scientists are not completely sure how to prevent asthma from developing in the first place.<sup>14</sup> However, evidence points towards events in growth and development that predispose airway tissues to react to asthma triggers as a potential cause of the disease. These events can involve either direct inflammation of airway tissues, or potentially the alteration of immune system development in ways that increase the sensitivity of airway tissues and thus the frequency of inflammatory response.<sup>15</sup>

Genetic factors can predispose individuals toward developing asthma. Age, sex,

socioeconomic status, nutritional status, and exposure to outdoor air pollution are also relevant.<sup>16</sup>

However, these factors alone cannot explain such dramatic increases in asthma prevalence over such a short period of time. The distribution of age and sex in the human population is not changing very quickly over time. Outdoor air pollution levels are declining relative to the 1970s and 1980s, making it difficult to blame increased asthma prevalence on outdoor air pollution alone. Similarly, fewer people smoke cigarettes now than in previous decades, meaning that increased exposure to second-hand smoke probably cannot explain why more children have the disease today.

Possible factors that could be at least partially responsible for the increasing prevalence of asthma include exposure to toxic chemicals from consumer products that we touch, or from products that contaminate the air within our homes, schools and workplaces.<sup>17</sup>

## Children are Particularly Vulnerable to Harm

Young children are brought to the ED for asthma more often than adults

Children have unique physiologic, developmental, and behavioral differences that make them more vulnerable to harm

from exposures to toxic chemicals. First, children are exposed to larger relative doses of toxic chemicals. Because children are smaller than adults, their skin-to-body mass ratio is greater. Children eat more food,

drink more water, and breathe more air per unit of body weight than adults, and children of all ages spend more time on the ground, coming into more contact with contaminants.<sup>18</sup> According to EPA, infants ingest twice as much dust, weigh one sixth as much, and are up to ten times more vulnerable than are adults to dust exposure. The developing bodily systems of infants are easily affected at low doses and these systems are less able to metabolize, detoxify, and excrete pollutants. In addition, because infants and young children mouth nonfood items and crawl on floors, they may ingest higher levels of dust as well as breathe more airborne pollutants that remain closer to the floor.

Second, children are undergoing rapid change during the complicated processes of



growth and development. Exposure to a toxic chemical during a key window of time can interfere with the proper development of tissue, or cell programming, resulting in life-long damage that might not become apparent until much later on in life. Leading experts on developmental biology and toxicology have concluded that:

- Chemicals in the mother's body will be shared with a fetus developing in her womb or with her nursing baby – and the child's dose may in some cases be larger than the mother's relative to body weight.
- The process of development creates windows of vulnerability to a wide range of adverse effects.
- "Developmental exposures to environmental chemicals can lead to life-long functional deficits and disease."<sup>19</sup>

## Disparities in Asthma Incidence

In Maryland, asthma emergency department visits for Black/ African Americans are significantly higher than the rate of Whites (150.0 vs. 29.7 per 10,000). Black/African American people visit the emergency department for asthma at four times the rate of white people. According to the CDC, "black children are two times more likely to have asthma than white children."<sup>20</sup>

Boys are more likely to have asthma than girls, although in adults asthma affects more women. Adults who didn't finish high school are more likely to have asthma than adults who did, and adults with an annual income of less than \$75,000 are more likely to have asthma than adults with higher incomes.<sup>21</sup>

# Exposure to Toxic Chemicals Can Cause or Aggravate Asthma

A growing body of evidence suggests that exposure to toxic chemicals from consumer products may increase the risk of developing asthma, as well as triggering asthma attacks.<sup>22</sup> Extensive evidence from occupational and epidemiological studies, as well as medical case reports demonstrate that hundreds of chemicals may cause asthma in individuals previously free of the disease, or place asthma patients at greater risk for subsequent attacks. Many of these chemicals are present in consumer products and objects that we often encounter in everyday life within our homes, schools and workplaces.

## Many Chemicals in Consumer Products and the Built Environment are linked to Asthma

Asthma can be triggered by exposure to chemicals present in products found indoors, including chemicals in plastics, chemicals in building material, paint, and furniture, cleaning products, fragranced cosmetics, scented products and many other indoor pollutants.

Many studies link indoor residential chemical emissions and respiratory health or allergy problems in infants or children. NIH identified 374 different substances-naturally occurring and man-made, that have known or suspected links to asthma.<sup>23</sup> Researchers came to the conclusion that “the substances that are commonly linked with asthma are ubiquitous. From a kindergartner, to a nurse or a manufacturing plant worker, everyone is exposed to these substances in their respective environments.”

Such research has identified chemicals including formaldehyde in particleboard, phthalates in plastic materials, and recent painting as frequent risk factors. Elevated risks have been reported for renovation and cleaning activities, new furniture, and plastic flooring and wall covering. An abundance of evidence has accumulated linking chemicals to asthma development and aggravation, including phthalates and bisphenol-A in plastics; diisocyanates in sealants and spray foam insulation, glycol ethers in many cosmetic and cleaning products; and formaldehyde in furniture or building products made from composite wood. The following sections describe relevant research linking common indoor chemicals to asthma.

## *Phthalate Exposure May Increase Asthma Risk*

Phthalates are high production volume chemicals used primarily as plasticizers in polyvinyl-chloride (PVC) plastics, making plastic flexible. While some phthalates in certain children's products are regulated, the public, especially children, are still exposed to phthalates common in building materials and consumer products.

Scientists have found associations between exposure to phthalates and the development of asthma and allergies in people.<sup>24</sup> For example:

- In 2008, scientists in Denmark found an association between phthalates in indoor dust and wheezing among preschool children. A higher level of di(2-ethylhexyl) phthalate (DEHP) was found in homes of children with asthma symptoms. The presence of PVC flooring in the child's bedroom offered the strongest prediction of asthma symptoms.<sup>25</sup>
- After following the growth and development of children in one Swedish county for several years, scientists at Karlstad University in Sweden concluded that "asthma and allergy prevalence are associated with phthalate concentrations in settled dust in the children's bedroom."<sup>26</sup>
- In 2010, several of the same scientists surveyed published scientific literature worldwide, finding further indications of a

connection between phthalate exposure and the development of asthma in children. Specifically, they found evidence that phthalate exposure can alter the development of the immune system in ways that could predispose lung tissue to exhibit asthmatic characteristics.<sup>27</sup>

- In 2011, scientists published a review finding "strong and rather consistent indications that phthalates increase the risk of allergy and asthma and have an adverse impact on children's neurodevelopment."<sup>28</sup>

An abundance of research demonstrates that phthalate exposure is likely to occur through ingesting, touching or inhaling household dust. A 2008 study of indoor dust in homes in Davis, California found high contamination by persistent and endocrine-disrupting chemicals. In this study indoor dust samples were collected from household vacuum cleaner bags from 10 apartments and 1 community hall. Di-(2-ethylhexyl) phthalate was the most abundant in all samples.<sup>29</sup>



In a study published in 2011 indoor dust samples were collected from various

children's facilities (40 playrooms, 42 daycare centers, 44 kindergartens, and 42 indoor-playgrounds). Several phthalates—DEHP, DnBP and BBzP—were detected at high rates. The detection rates of DEHP were 98% in dust samples, 100% in surface wipe samples, and 95% in hand wipe samples.<sup>30</sup>

### ***Bisphenol-A Alters Immune System Development in Ways that Could Increase Asthma Risk***

Bisphenol-A (or BPA) is a very common chemical found in plastics, food and beverage can linings, store receipts and other consumer products. It was originally invented as a synthetic estrogen drug, but manufacturers later discovered that it could be used to make polycarbonate plastics.

According to the Centers for Disease Control and Prevention, 93 percent of Americans have detectable levels of BPA in their bodies at or above concentrations known to have adverse health effects.<sup>31</sup> Studies suggest that early-life exposures to BPA can alter important steps in growth and development, increasing the risk of developing diseases later in life – including asthma.

- In 2011, researchers at the Columbia Center for Children's Environmental Health found that the urinary BPA level in children at ages 3 and 7 years was associated with increased odds of asthma between the ages of 5 and 12.<sup>32</sup>
- Researchers from the Penn State College of Medicine found that

children whose mothers are exposed to BPA may end up at a higher risk for developing asthma early in life. In a study of 367 pairs of mothers and infants, researchers measured levels of BPA in the urine of pregnant women and found 99 percent of mothers had detectable levels of BPA at some point during pregnancy. At 6 months of age, infants whose mothers had high levels of BPA during pregnancy were twice as likely to wheeze as babies whose mothers had low levels of BPA.<sup>33</sup>

- In 2012, researchers at National Cheng Kung University in Taiwan found that children who used plastic feeding bottles (which are often made from bisphenol-A) were more likely to report wheezing and asthma symptoms. The effect appeared to increase in children who used feeding bottles for longer periods of time.<sup>34</sup>

Similar effects have been observed linking prenatal exposure to the banned chemical class PCBs – which, like BPA, also mimic hormone activity in the human body – with an increased risk of asthma development.<sup>35</sup>

Experiments with animal subjects support the idea that bisphenol-A exposure could affect immune system development in ways that increase the risk of asthma development. For example:

- In 2009 researchers at the University of Texas found that mice born to

mothers who had been exposed to bisphenol-A during pregnancy were more likely to develop asthma.<sup>36</sup>

- In one experiment, mouse pups exposed to BPA in utero and through breast milk, and in utero only, displayed asthma symptoms, whereas pups exposed to BPA from breast milk only did not. Researchers concluded that prenatal exposure, rather than early postnatal exposure, is the most critical for BPA to promote the development of asthma.<sup>37</sup>
- A study published in 2013 by researchers at the UC Davis National Primate Research Center found that fetuses of pregnant rhesus macaque monkeys exposed to BPA suffered from changes in their lungs that increased the potential for developing asthma.<sup>38</sup>

### Some Volatile Organic Pollutants Cause or Aggravate Asthma

Volatile organic pollutants can contaminate the air inside homes, schools or workplaces. These chemicals – such as benzene, toluene, and xylene – come from sources including motor vehicle exhaust, gasoline, cigarette smoke, solvent-based paints, floor adhesives, PVC flooring, carpeting, printed material and solvent-based consumer products. Dozens of these chemicals have long been recognized as hazardous, but remain in commercial uses that may put vulnerable populations at risk. Hundreds more have become a part of our children's

indoor environment with little understanding of their potential to harm human health.

Recent research adds to the evidence linking exposure to certain volatile organic pollutants to asthma development and aggravation:

- In a 2008 study of a representative sample of the U.S. population, environmental exposures to volatile organic pollutants were associated with adverse respiratory effects.<sup>39</sup>
- Increased levels of inflammatory markers in children's blood – consistent with asthma – were related to renovation activities in a 2008 study of 6-year-old children. Parents filled out surveys on indoor renovation activities (painting, flooring, and new furniture). Among renovation activities, floor coverings were found to induce the strongest inflammatory reactions.<sup>40</sup>
- In a 2010 study, researchers found that toluene, benzene and styrene induce inflammatory reactions consistent with asthma symptoms in human lung cells.<sup>41</sup>
- A 2010 French study found that high concentrations of VOCs in homes were associated with asthma and rhinitis in adults. The national survey assessed 20 VOCs in 490 homes after determining the prevalence of asthma and rhinitis among the more than 1,000 adult residents. Asthma was significantly associated with N-undecane and 1,2,4-trimethylbenzene. Aromatic

hydrocarbons and aliphatic hydrocarbons were significantly associated with a risk of asthma.<sup>42</sup>

- Volatile compounds commonly used in plastic flooring have been found to be more prevalent and in higher concentrations in the homes of people recently diagnosed with asthma. Finnish scientists in 2008 found that “compounds commonly used in plastic flooring manufacture (such as 2,2,4-trimethyl-1,3-pentanediol di-isobutyrate) were found to be more prevalent and in higher concentrations in the homes of subjects having newly diagnosed asthma.”<sup>43</sup>
- Researchers investigated the influence of low-level inhalation of toluene on immune system cells in mice, finding low-level exposure resulted in asthma symptoms.<sup>44</sup>
- A 2010 investigation of the relationship between sensitivity to toluene exposure and genetic background shows toluene-induced immune disturbance.<sup>45</sup>
- A 2009 study found that mouse pups whose mothers were exposed to low levels of toluene may induce immune responses resulting in asthma.<sup>46</sup>

### ***Diisocyanates continue to be widely used, despite hazard***

Toluene diisocyanate (TDI), methylene diphenyl diisocyanate (MDI) and similar chemicals are well known hazards. They

have been documented to cause asthma, lung damage, and in severe cases, fatal reactions. EPA describes the TDI chemicals as “potent dermal and lung sensitizers and a major cause of work-related asthma worldwide.”<sup>47</sup> While occupational safety rules restrict diisocyanate exposure in the workplace, diisocyanates continue to be used widely in ways that put not only workers but everyday Marylanders, especially children, at risk. Consumer products with the hazardous chemicals, for example spray foam insulation, sealants and adhesives are increasingly used by consumers. A 2011 action plan on diisocyanates published by EPA reported that consumer products containing diisocyanates put direct users, bystanders and building occupants at risk for the potential health effects. Products containing diisocyanates such as spray foam insulation, sealants and adhesives are increasingly available to and used by consumers outside of the workplace, where consumers are uninformed of the health risks and may use the product improperly unintentionally—or intentionally. Both commercial and residential applications put bystanders and building occupants, especially children, at risk—not only during application but also during the lifespan of the product. For example, air sampling revealed TDI in buildings with wood floor coating containing TDI. Children exposed to the same levels of TDI vapor as adults may receive a larger dose because they have greater lung surface area, according to EPA. In addition, EPA states that TDI vapor is heavier than air and may layer close to the

floor, thus putting children at a greater risk for inhaling the vapor.

### *Glycol Ether Exposure Is Common*

Glycol ethers are volatile chemicals widely used in food, pharmaceutical, cosmetic and cleaning products, as well as water-based paint additives. Propylene glycol and glycol ether (PGE) in indoor air have recently been associated with asthma and allergies as well as allergic sensitization in children:

- In a 2010 report, researchers found PGE exposure through indoor air and dust to be a significant risk factor for asthma and allergy development in pre-school age children in Sweden.<sup>48</sup>
- A separate group of researchers found that indoor exposure to glycol ethers in children aged 3-8 was associated with an increasing risk of having asthma. Larger exposures were correlated with larger effects.<sup>49</sup>
- Another recent study also found that glycol ethers in indoor air exacerbate and/or induce asthma, rhinitis and eczema. Researchers found propylene glycol and glycol ethers (PGEs) in bedroom air to be associated with a 1.5-fold greater likelihood of asthma.<sup>50</sup>



### *Formaldehyde Exposure Damages the Lungs*

Formaldehyde is a volatile organic compound widely used in building materials and a variety of household products. For example, manufacturers use formaldehyde as a component in glues and adhesives, as a preservative in paints and related products, and as a means to give fabrics a permanent-press quality.

When used in consumer product or the built environment, formaldehyde-containing products can release the chemical into indoor air. In particular, products made from composite wood containing urea-formaldehyde glue tend to create indoor air pollution.<sup>51</sup> Formaldehyde off-gassing (the

release of a substance from the product into the surrounding air) from building materials and other products can lead to indoor formaldehyde concentrations far exceeding outdoor levels, making childhood exposure common.<sup>52</sup> In a recent California study, nearly all new single-family homes had indoor formaldehyde

concentrations that exceeded guidelines meant to prevent cancer and chronic lung irritation.<sup>53</sup>

Potential formaldehyde emission sources within a home include furniture and building materials made from composite wood; some types of fiberglass insulation; permanent press textiles; cosmetics and combustion sources, including cigarettes.<sup>54</sup>



In homes, composite wood products made with urea-formaldehyde resin are likely to be among the most significant sources of airborne formaldehyde. Manufacturers use urea-formaldehyde because it is cheap and transparent. However, products made with this adhesive tend to have very high formaldehyde emissions, which continue for several years after manufacture.<sup>55</sup> Heat and humidity tend to accelerate formaldehyde emissions, especially when a product is new.<sup>56</sup> In particular, Medium Density Fiberboard (MDF), a type of composite wood widely used in building materials and furniture, is a notorious source of formaldehyde vapor in the home.<sup>57</sup> Particle board and hardwood plywood are two additional types of compressed wood made with formaldehyde-based glue. Recent scientific studies confirm that children chronically exposed to elevated levels of airborne formaldehyde face an increased risk of developing allergic sensitivities and/or asthma.<sup>58</sup>

Infants exposed to higher levels of formaldehyde in their bedrooms were more

likely to develop wheezing symptoms in their first 18 months of life in a study conducted in Hong Kong during 2009.<sup>59</sup>

A 2011 study pooled the results of seven published studies and found a positive relationship between formaldehyde exposure and childhood asthma. Overall, individuals with the highest level of formaldehyde exposure in the studies were 3.5 times more likely to have asthma than those with the lowest exposure.<sup>60</sup>

In April 2011 the Occupational Safety and Health Administration (OSHA) issued a hazard alert to warn salon owners and workers about the potential health effects of formaldehyde exposures from hair-straightening products. Some of the products contained formaldehyde without listing it on the label, while others contained the chemical yet were labeled “formaldehyde-free.”<sup>61</sup>

A 2010 survey of 969 elementary school students studied asthma and wheeze symptoms, exposure to tobacco smoke, and home environment including history of moving into a new house within one year of age after birth, use of fragrance at home, and recent purchase of new furniture – potential markers of increased exposure to volatile chemicals like formaldehyde. Moving into a new house within one year of birth was associated with current asthma or wheeze. Use of fragrance at home and purchase of new furniture during the past 1 year were associated with current wheeze, current physician-diagnosed asthma, and nocturnal cough.<sup>62</sup>

## Cleaning Products Have Links with Asthma

Exposure to volatile chemicals in cleaning products may be responsible for asthma development and aggravation. Exposure to cleaning sprays, chlorine bleach and other disinfectants may be particularly relevant. For example:

A large international population study showed an increased risk of new-onset asthma associated with cleaning work, with professional use of cleaning products and with domestic use of cleaning sprays. Three surveillance studies confirmed occupational asthma cases among cleaners and others who use cleaning products at work. Six workforce studies showed that respiratory symptoms are partly work-related, and are associated with specific exposures including sprays, chlorine bleach and other disinfectants.<sup>63</sup>

A study published in 2012 found that healthcare professionals are at risk of developing asthma from exposure to cleaning substances. A total of 3,650 healthcare professionals responded to a validated questionnaire about their occupation, asthma diagnosis, variability of asthma symptoms at and away from work, and exposure to cleaning substances. The odds of asthma increased for exposure in the longest job involving cleaning agents and disinfectants/sterilants, respectively. The use of bleach, cleaners/abrasives, toilet cleaners,

detergents and ammonia, glutaraldehyde/ortho-phthaldehyde, ethylene oxide and formalin/formaldehyde increased the odds of asthma. Exposure to chloramines was significantly associated with an almost five fold elevated odds of asthma.<sup>64</sup>

In a 2009 survey of nurses, workplace exposures to cleaning products and disinfectants was found to increase the risk of new asthma. Occupational exposures included cleaning tasks, use of powdered latex gloves, exposure to aerosolized medications, and tasks involving adhesives, glues or solvents. The incidence of reported asthma was significantly greater among nursing professionals involved in medical instrument cleaning and exposure to cleaning products and disinfectants. Use of powdered latex was associated with 1.6 times the odds of reported asthma. Exposure to adhesives, glues and solvents was associated with a twofold increase in reported asthma.<sup>65</sup>

A study published in 2011 concluded that 45 percent of occupational asthma among long term female professional cleaners was attributed not only to cleaning chemicals but also to other chemicals used in work environments.<sup>66</sup>



## Maryland Schoolchildren and Teachers at Risk

Schools with poor ventilation, mold and moisture have been linked to greater numbers of children reporting asthmatic symptoms.<sup>67</sup> School buildings are densely

occupied and have rigorous cleaning and maintenance needs. And of course, the majority of school occupants are children. Increasingly, female teachers of reproductive age make up the teaching staff.<sup>68</sup> Children and teachers are not protected by OSHA (Occupational Safety and Health Administration) regulations, which only apply to the person who receives paid compensation for using a hazardous substance during the course of their regular work activities. Research indicates teachers and custodians have high rates of work related asthma.

### *Cleaning products used in schools contain chemicals tied to asthma*

Six chemicals known to cause asthma (formaldehyde, styrene, methyl methacrylate, ethanolamine, alkyl dimethyl benzyl ammonium chloride, and didecyl dimethyl benzyl ammonium chloride) were present in cleaning products used in schools that Environmental Working Group (EWG) tested for indoor air pollutants.<sup>69</sup>

Cleaning products also contribute to asthma indirectly by releasing a host of VOCs that form ozone when in the presence of other widely distributed air contaminants composed of nitrogen and oxygen. Ozone is the primary component of smog that can trigger asthma, and may form during and after use of cleaning supplies that release VOCs.

Certified green products contained fewer known toxic ingredients, according to laboratory tests and analysis of company documents by the Environmental Working Group. On average, green general purpose

cleaners contained one-fourth as many chemicals with documented health concerns as similar conventional products. Among all cleaning supplies tested, certified green products contained one-third the chemicals with documented health concerns. Leading green certifications include Green Seal and EcoLogo. Green Seal and EcoLogo establish environmental and health requirements for general purpose, restroom, glass, and carpet cleaners, intended for routine cleaning of schools, offices, and institutions.

Green Seal's standard was recently revised to include a prohibition on chemicals that are known to cause asthma through the process called respiratory sensitization. Green Seal and EcoLogo standards, which are revised periodically, also establish specific limits on ingredients for acute toxicity; skin absorption; inhalation toxicity; toxicity to aquatic life; bioaccumulating compounds; nutrient pollution; and fragrances. Other criteria in these standards guide a product's pH, combustibility, VOC content, and biodegradability. Green Seal's certification standard prohibits certified green products from containing ingredients classified as both asthmagens and sensitizers.

### *Successful State Procurement of Safe Cleaning Supplies*

Lax federal health protections have led to a variety of state efforts to protect children, faculty, and staff from toxic cleaning products in schools. Eight states have passed laws encouraging the use of green school cleaning supplies, while New York and Illinois have mandated the use of these types

of products. In 2009, Maryland passed the Act Concerning County Boards of Education – Procurement of Green Product Cleaning Supplies, but this law remains largely unimplemented in Maryland schools, which are allowed to opt out of complying with the law simply by writing a letter stating economic hardship. In fact, green cleaning products have saved school systems money, but more guidance and training are needed to assist school facilities managers in switching to certified green products.

### ***Protections needed during construction and renovations***

Currently there are no provisions in the Maryland Law or Federal Law to ensure basic safeguards to protect school building

occupants during any construction, renovation, maintenance or custodial activities or even during times when hazardous substances are introduced into a classroom for education or instructional purposes. According to EPA, renovation is one of the major causes of poor indoor air quality in schools, and is often conducted while the building is occupied, resulting in potentially important exposures of occupants to dust, fumes, and hazardous contaminants such as lead or asbestos. Demolition can release toxic materials (e.g., lead, asbestos, or mold), construction causes dust and fumes, and off-gassing from building materials and new products occurs. Modeling and advancing sustainability best practices through building design and redesign is necessary to protect our children in school.

# State and Federal Chemical Regulations Fail to Protect Our Health

The Toxic Substances Control Act (TSCA) of 1976 does not adequately protect Americans from toxic chemicals. Gaping holes in chemical safety law contributes to the preventable burden of toxic chemicals in our indoor air. Under the current system tens of thousands of chemicals have been allowed into commercial use without proof of safety. Consumers, retailers, and other downstream users of chemicals (including manufacturers of and distributors of products) cannot gain access to basic information about the chemicals used to make their products. Because TSCA does not ensure the right to know, we don't have the information we need to identify all the sources of indoor air pollution that are causing and contributing to asthma.

Current risk assessments by state and federal officials are not adequately capturing multiple exposures to chemicals, complex mixtures of chemicals, and the fact that some populations are disproportionately exposed to chemicals.

Removing a chemical from inappropriate uses should not take decades. Formaldehyde was in use before TSCA existed, but after 35 years is still polluting our homes.

How can an expectant mother determine if there is formaldehyde in the particleboard used to make home furnishings? How does a new father decide which kitchen floor may contain and release phthalates? Why should parents even have to worry about whether dangerous chemicals are in the products they choose for their families? We need to ensure that information is available to make responsible choices as a society about what chemicals we choose to include in our lives – and our bodies. Marylanders need to be able to identify and avoid chemical asthma triggers in their everyday environments.

## Policy Recommendations

Public policy reforms at the local, state, and national level are needed to reduce exposure to chemical asthma triggers and irritants.

### Right to Know

The public has the right to know about chemicals currently on the market, including their specific uses, potential hazards and potential routes of exposure. Information should enable business and consumers to compare the safety of chemicals, identify missing data, and create demand for safer alternatives. Until health and safety data are available for a chemical, there should be a mandatory labeling for products indicating the presence of a chemical that has not been tested for its impact on human health. This is the responsibility of the chemical industry and the product maker. Unfortunately, this powerful industry has successfully avoided meaningful regulation from the beginning. When TSCA was passed by Congress in 1976, more than 60,000 chemicals were grandfathered into commerce with no assurance of safety. Confidential business information and trade secrets allow companies to hide a product's true ingredients from the user. As some of the research reviewed in this report has found, for every known chemical of concern detected in the indoor environment, dozens more unknown chemicals are also detected. Congress must act to stop the chemical industry from using Americans as lab rats, and shift the burden of proof onto industry and away from the already overburdened

consumer, academic and government organizations.

### *Educate Marylanders about chemicals of concern*

In the meantime, Maryland families should have access to information about chemicals of concern, as should health care providers, employers, schools, and daycare facilities. For citizens to have easy access to a list of chemicals of concern and their potential health effects, an online database has been established in some states. Maryland agencies charged with protecting the health of Marylanders should follow suit, and publish a list of chemicals of concern. There are a number of lists of chemicals of concern produced by government agencies, academic sources, and third-party regulatory agencies. Maryland needs a statewide list of chemicals of concern that can be trusted by the many divisions of state and local government working to make Marylanders and our communities healthier. Maryland parents, childcare providers, and health professionals need a resource they can turn to know what chemicals-- in what uses-- can put our health at risk, cause cancer, reproductive or developmental harm, or trigger an asthma attack.

With the federal government still dragging their feet on updating (or implementing, for that matter) the decades old TSCA, states like Maryland with a high asthma burden must act now to reduce toxic exposures. The first step is educating our most

vulnerable citizens. Whether it is a parent looking for consolidated advice about chemicals their child may be exposed to at school or at home, or a health professional that thinks her patient's asthma may be related to indoor air pollutants, Marylanders need information they can trust.

### *States require data reporting*

The federal government has failed to require chemical data reporting from manufacturers --even basic information on the health hazards associated with their chemicals, how they are used, and the ways that the public or workers could be exposed. Because of this, several states have required manufacturers disclose the presence of toxic chemicals in products and the associated hazards and risks, to regulators, businesses, and the public.

Maryland should participate in collaborative efforts with other government agencies to manage chemical information, save resources in the identification and prioritization of chemicals, as well the assessment of alternate chemicals. Fourteen states are members of the Interstate Chemical Clearinghouse, a partnership specifically created to help state agencies build their capacity to identify and prioritize chemicals of concern, assess the safety of alternative chemicals, and manage chemical data.

### *Streamline Action on the Worst Chemicals*

Chemicals which are known to be persistent, bioaccumulative, toxicants (PBTs), endocrine disrupting chemicals (EDCs),

carcinogens, mutagens, or reproductive toxicants (CMRs) are uniquely hazardous. Any such chemical to which Marylanders could be exposed should be phased out of consumer products. Known chemical asthma triggers and irritants should also be restricted from uses that put vulnerable populations at risk. Groups of chemicals with similar properties, such as MDIs and TDIs, for example, should be prioritized for replacement as opposed to one-by-one restrictions. Individual chemicals restrictions in states like Maryland have helped to push industry to phase out certain dangerous chemicals, but often result in another similar chemical taking the place of the restricted chemical. Until chemical manufacturers prove their chemicals are safe before they come onto the market, EPA should take expedited action to restrict known hazards to the fullest extent of their authority.

### *Prevention Efforts Should Target Vulnerable Populations, Schools, Healthcare Providers*

Because of the vulnerability of children, pregnant women, urban and minority populations, preventative efforts should target schools, hospitals, daycare facilities, and urban and minority communities. Education and intervention can aid in reducing the use of chemical asthma triggers and irritants.

The Maryland Asthma Control Program, a project of the Department of Health and Mental Hygiene, has a number of projects targeting populations vulnerable to asthma.

Maryland agency heads, non-government organizations and lawmakers should work

together to give these and other prevention efforts the resources needed to reach more Marylanders with asthma.

### Use the Best Science and Methods

The National Academy of Sciences' recommendations for reforming risk assessment at the Environmental Protection Agency (EPA) should be adopted. The Academy recommends assessment is based on information about hazards, proposed use, and potential exposures. Hazard implies intrinsic properties of chemicals or classes, like persistence, carcinogenicity, or neurotoxicity. When appropriate for hazard determination, there must be consideration of aggregate and cumulative exposure, as well as exposure to mixtures (chemicals that co-occur within and across products).

Research shows that one product may be a source of multiple chemicals of concern—and multiple products can result in exposure to an even larger number of chemicals.<sup>70</sup>

### Promote Safer Alternatives and Maryland-based Innovation

Maryland is in a unique position to contribute innovative solutions for safe product development, and should support and encourage green chemistry research, development, education, and research and technology transfer. Education and training of undergraduate and graduate students, and professional chemists and chemical engineers, through partnerships with the state, universities, and industry, should be a part of this initiative.

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